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THE RELATION OF CHEMICAL LABORATORIES TO THE NATIONAL WELFARE[1]

FOR two years and a half the world has been in a ferment. On the basis of an incident which now seems trivial, the mutual jealousies and distrust of the nations of Europe precipitated a war in which the interests of all the nations of the world are involved. Those of us who think that our race is progressing toward better conditions can not but believe that there will grow out of this war some better method of settling differences between nations. The duel as a means of settling private quarrels has long since disappeared in England and America. It must surely cease as a means of settling quarrels between nations. It seems certain that the time will come when the world will look back to these years as a time of madness like the madness that drove men to the crusades of the middle ages.

With all the loss and waste and dreadful suffering of these years the nations of the world are learning some lessons which would not have been learned in times of peace. Russia has solved her liquor problem for the time being. Germany enforces a democratic equality in the distribution of food which is beyond the wildest dream of the socialists. Bread is distributed by cards and the wealthiest citizen can get no more than the day laborer. England has solved the problem of the unemployed—there is no longer a "submerged tenth" for whom conditions are utterly hopeless. One of my friends who has been in London with

[1] An address delivered at the dedication of the chemical laboratory of the University of Oklahoma, January 26, 1917.

his family reports that his wife was commiserating her charwoman on the suffering of the war, when the latter replied: "It's not so bad—a pun' a week and the man away from home—it's too good to last."

In America, too, we are learning some lessons—among others that our industrial independence, at least in the matter of dyes for our textiles, is of some importance.

If we try to find a single word which expresses that for which all of the warring nations are striving it is *efficiency*. It seems very dreadful that the desire to slaughter our fellow men should be the incentive, and if we did not believe that the lessons learned under the stress of war will remain during the long years of peace that are to follow, we might well wish for the good old times before scientific efficiency was thought of. But whether we will or not a new sort of efficiency has come to stay and it is worth our while, here in America, to grasp its meaning and to look for the foundation on which it has been built.

I see with the eyes of a chemist, of course, and shall draw my illustrations from the science which I know best, but much that I have to say applies to other sciences as well.

A little less than one hundred years ago, shortly after Europe had settled down from the tumult of the Napoleonic wars a young German doctor of philosophy, not yet out of his teens, went to Paris to study chemistry and succeeded in gaining admission to the private laboratory of Gay Lussac. Liebig was a born chemist, if ever there was one, and had worked with things chemical from early boyhood. But even Liebig needed the inspiration of contact with one of the master chemists of his time, and this Gay Lussac gave him. After a few months he returned to Giessen and there in a laboratory which was new of its kind in university life he gathered about him an enthusiastic group of young men who came to him for the study of chemistry. The laboratory was very crude and primitive in comparison with the palaces of science which we build to-day, but out of that laboratory went influences which have spread over the whole world—Liebig's idea of a laboratory was not that it is chiefly a place for teaching what is already known, but rather that it is a workshop where teacher and pupil are striving together to learn something new from the great book of nature. Very soon many similar laboratories sprang up and within a few years Germany became the country to which young men resorted from all over the world for the study of chemistry.

A. W. Hofmann, one of the talented young men of the Giessen group, was called to London by Prince Albert in 1845. There he taught in the college of chemistry. He employed as an honorary assistant, some years later, a young man by the name of William H. Perkin. Young Perkin became so interested in the subject that he was not content merely to work with Hofmann during the day, but he fitted up a private laboratory at home where he could work at night. Here he tried to do some experiments in the hope of obtaining a synthesis of quinine. His first experiments gave an unattractive reddish brown precipitate of the sort that most chemists would pass by as hopeless. He became interested, however, and tried similar experiments with a simpler substance, aniline. The product was at first still more unpromising, but on further examination he found that it contained a beautiful purple coloring-matter which was capable of dyeing silk and other textiles. It was in fact the substance we now know as the "Mauve dye." Perkin, then a lad of only eighteen years, conceived the daring idea that this color might be put to practical use. Fortunately his father had faith enough in his ability to

furnish him with the necessary financial assistance. It was a new thing under the sun and it is fascinating to read of the difficulties met and overcome in developing the industry of the coal-tar dyes. The benzene which is now separated from coal-tar to the amount of thousands of tons annually was not to be had as a definite product and it was necessary to invent the machinery and apparatus for carrying out on a large scale operations which, hitherto, had been tried only in test-tubes. Even when the new dye had been made, the dyers, who were accustomed only to vegetable dyes, could not use the product and Perkin had to go into their dyehouses and teach them how to handle the material. All of these difficulties were finally overcome and a successful foundation was laid for a great industry, which in less than a generation revolutionized the artistic beauty of our wearing apparel.

A few years later two German chemists solved the riddle of the structure of alizarin, the coloring matter of madder root, and showed that the dye could be made from the anthracene of coal tar. They did not, however, put the production of the material on a commercial basis and here, again, it was William H. Perkin who worked out the economic details of manufacture in his factory.

With such a beginning it would have seemed that England must be the leader in the manufacture of artificial dyes, but long before the end of the nineteenth century Great Britain had lost all her initial advantage and Germany was preeminent in the production of synthetic colors.

When we look for the reason for this surprising result we find it almost entirely in the laboratories founded on Liebig's ideal —laboratories where students learned the chemistry already known, it is true, but where, much more than that, and as their prime object, teachers and pupils gave their energies intensely and incessantly to the development of an ever-changing science. Young men trained in such an atmosphere proved to be the very ones who could solve the varied problems of an industry which is so intimately connected with investigations in pure science. In addition to the supply of trained chemists furnished by the universities there grew up a most intimate connection between the university laboratories and the factories where dyes were made. An illustration will help to make this clear. Kekulè, one of the men who worked with Liebig in Giessen, proposed his theory of the structure of benzene in 1865. This has become, perhaps, the most important single thought guiding the work of the color-chemists even to the present day. Baeyer, who had studied with Kekulè, took up, in the same year, some work on isatin, an oxidation product of indigo. He tells us with what pleasure he had spent for a piece of indigo a birthday present of two thalers, given him when he was thirteen, and with what a feeling of reverence he drew in the odor of orthonitrophenol while he was preparing isatin from it by the directions which he found in an organic chemistry.

After working upon isatin and other derivatives of indigo for four years with good success Professor Baeyer dropped the subject for eight years because his former teacher Kekulè published a paper in which he announced that he was attempting a synthesis of isatin. It was evident that Kekulè did not succeed and in 1877 Baeyer felt justified in taking up the subject again. Three years later he discovered a synthesis of indigo which was of sufficient promise for a patent and the Badische Anilin Soda Fabrik began at once an attempt to put the synthesis on a manufacturing basis. But a successful synthesis in the laboratory is very different from successful production in a factory. The chemists of the factory worked over the process from every pos-

sible point of view for fifteen years. The various steps in the process were greatly improved and more than a hundred patents were taken out, but it was never possible to convert Baeyer's synthesis into a successful manufacture of indigo on a large scale. The original material required for that synthesis is the toluene of coal tar and the annual production of this substance would be sufficient to produce only about one fourth of the indigo required in the world. As toluene is used in the manufacture of a great variety of other dyes and compounds it is evident that any considerable use for the manufacture of indigo would cause such an increase in price as automatically to stop the manufacture. No manufacture of indigo could succeed unless the dye were made at a price to compete with the agricultural production in India.

The factory found its way out of this *cul-de-sac* by means of a discovery made by Professor Heumann in the chemical laboratory of the Polytechnic at Zurich, Switzerland—a laboratory which has given us many brilliant discoveries in chemistry and which is conducted on a high scientific plane, not on the theory that it must devote itself to so-called practical problems. By combining Heumann's discovery with another made by Hoogewerf and van Dorp in a laboratory in Holland it became possible to manufacture indigo with naphthalene of coal tar as the starting-point. Naphthalene, known to us all in the familiar moth balls, is abundant and cheap.

Even with the aid of these fundamental discoveries from the university laboratories the chemists of the factory worked incessantly upon the problem for seven years before they felt sufficiently sure of their ground to recommend the building of a plant for the manufacture on a large scale. Two incidents of the development are of sufficient interest to deserve mention. The first step in the process is the oxidation of naphthalene to phthalic acid. The processes which had been used before that were too tedious and expensive. In the course of a systematic examination of all possible methods for cheapening the process a chemist accidentally broke a thermometer in a mixture of naphthalene and sulfuric acid which he was heating. The mercuric sulfate which was formed proved to be the needed catalyst to hasten the reaction and the details of a successful process for the oxidation were soon developed. But, as is so often the case, the solution of one problem brought out a second difficulty. Strong sulfuric acid is required for the oxidation and this is reduced to sulfur dioxide, which it is necessary to recover and convert back into the strong acid by oxidation with air. This led to the transformation of the old and well-known contact process for the manufacture of sulfuric acid into a new and radically changed form. Incidentally it may be remarked that the new contact process soon found its way to America and has been used to convert to sulfuric acid the sulfur dioxide obtained as the first step in the reduction of zinc ores. The strong sulfuric acid has been used, in turn, in making dynamite.

Finally, in July, 1897, the preliminary work was completed and the Badische Anilin Soda Fabrik was ready to begin the construction of the necessary factories. In October, 1900, Dr. Brunck reported that the firm had spent about eighteen million marks or four and a half million dollars upon their plant and that the production had already attained a proportion which corresponded with the natural production from 100,000 hectares or nearly 250,000 acres of land. In reply to the suggestion that the competition might prove disastrous to the farmers of India he expressed the hope that the land now used for the production of indigo may be released for rais-

ing food stuffs, often sorely needed during the famines in that country.

It has seemed worth while to consider this development of the manufacture of indigo in detail because it points out so clearly the road which we must travel in America if we are to succeed in the color industry. It is a lesson which American manufacturers are learning, too, and this promises well for the future. A manufacturer in Michigan has recently taken a promising research worker in organic chemistry from the University of Michigan to help him develop the manufacture of indigo, and another manufacturer in Buffalo last summer called a man from the University of Illinois at twice the salary he was paid there, to organize a research laboratory for the manufacture of dyes. In each case the man secured his training in the research work of a university laboratory.

At the beginning of the war we were using dyes in the United States to the value of about $15,000,000 a year. Of this amount only about $3,000,000 worth were made in America. Nearly all the rest came from Germany. Textile industries having a product worth hundreds of millions are directly dependent on dyes and there is scarcely a person in this country who has not seen in some form the effect of the shortage. The dye manufacturers have been alive to the situation and in another year they will be able to furnish the quantity of dyes required, though they will not be able to furnish as great a variety as were formerly used.

We have heard a good deal, in recent years, about a scientific tariff commission. The action of Congress last summer illustrates the need of such a commission. The importance of making ourselves independent of other countries had become so evident that a bill was introduced providing for an *ad valorem* tax on dyes of 30 per cent. and a specific tax of 5 cents per pound. The specific tax is to continue for five years. At the end of that time it is to be decreased one cent a year till it disappears. There is also a provision that if the American factories do not produce 60 per cent. of the value of our home consumption at the end of five years the specific duties are to be completely repealed. While the specific duty is only two thirds of the amount which had been recommended by the New York Section of the American Chemical Society, it might, perhaps, have been sufficient if it were not for another provision which was allowed to creep in. Apparently at the instigation of some large user of dyes, indigo, alizarin and their derivatives were excluded from the specific duties. No logical reason, whatever, can be given for this exclusion. It must be due either to stupidity or to an attempt to favor some special interests. As this class of dyes constitutes 29 per cent. of the whole and at least 10 per cent. of the other dyes are covered by foreign patents, it is evident that the hope that our factories will produce 60 per cent. of our dyes in normal conditions of foregin competition is small.

Still other difficulties beset the industry. The manufacturers of dyes in Germany have very definite arrangements by which one dye is made by one firm, another by a second, and still another by a third so that there is no real competition in the manufacture of staple products. Such combinations are fostered rather than hindered by the German government, but similar combinations in this country are forbidden by the Sherman law. The way out of this difficulty seems to be in the first place a census of dyes showing what dyes are used and the quantities of each. Such a census has already been prepared by the expert of the Department of Commerce and Labor. If we can combine with this, in accordance with a suggestion of Dr. Herty, the editor of our *Journal of Industrial and Engineer-*

ing Chemistry, a frank statement by manufacturers, of the dyes which they intend to make, we may find a solution of this problem which is in accord with the democratic equality of opportunity which the Sherman law is designed to conserve.

The greatest fear of the manufacturers is that after the war they may be subjected to an unfair competition designed to destroy the new industry. The following story was told during a discussion of the dyestuff situation which was held in New York in September. Mr. Dow, of Midland, Michigan, discovered a good many years ago that the salt brines of Michigan contain enough bromine so that the element can be economically produced, and in the course of a few years he developed the manufacture to such a point that he shipped some bromine to Germany. Not long after a German appeared at his works in Midland and said to him: "I have conclusive evidence that you have been selling your bromine in Germany. Didn't you know that you can't do that?" Mr. Dow replied that he knew of no law against it. The German said "Well you can not. If you do, we will sell two pounds of bromine in America for every pound you sell in Germany." Mr. Dow paid no attention to the threat but went on with the production of bromine. Some months later when he was in Texas on business he received a telegram "Bromine is selling at 15 cents." A normal price is 75 cents. Mr. Dow closed his story at this point. The representative of the German Kali-Industrie, who was present, got up and asked him: "Well, wasn't it satisfactorly adjusted?" But he made no reply. I am fortunate enough to have heard the rest of the story —which is known to a good many outsiders, so I am betraying no confidence in telling you. Mr. Dow stopped selling bromine in America and sent his whole product to Germany. It was not long before the German manufacturers were ready to come to terms. Before the war Germany was manufacturing three fourths of the coal-tar dyes used in the world and we may be sure that she will not easily relinquish her position of preeminence in this field. Her manufacturers will surely attempt to destroy our manufacture of dyes by the same methods which were used to stop the manufacture of bromine—by the so-called "dumping" of materials here at prices below the cost of production. Laws have been passed by Congress imposing severe penalties for such practises, but some of our manufacturers are very sceptical as to their efficiency. We are not in as favorable a position to compete in the making of dyes as Mr. Dow was for the production of bromine.

I think it is clear from what has been said that the manufacture of dyes rests at its foundation upon the research work done in the chemical laboratories of the German universities and that we may trace it back very directly to the days when Liebig returned from France with the inspiration which came from Gay Lussac, and founded the laboratory in Giessen. One of the most important factors in the dreadful efficiency of Germany during the last three years may be traced back to the same source. Not a few of our leading men have emphasized the advantage of developing the dyestuff industry in America because the men trained in this industry will be most competent to handle the manufacture of explosives in case of war. Personally I have a strong hope that at the close of the war the world will be organized on the basis of justice instead of force, but for the present we can not ignore such arguments.

I wish to congratulate you on the completion of this laboratory at a most opportune time. We are in the midst of a very rapid development of our chemical industries. New lines of manufacture are being established and old lines are being rapidly developed. Manufacturers realize as they

have never done before how much chemistry can contribute to their success.

At the risk of seeming personal I will give a few illustrations of how chemical research in a single laboratory has demonstrated its value under American conditions.

A young man graduated from the course in chemical engineering at the University of Illinois in 1910. Soon after he was employed by a manufacturer of cement in the state of Washington. Something had gone wrong in the factory and hundreds of barrels of cement were rejected because the material did not meet the specifications. The young graduate, trained in methods of research, soon found the cause of the difficulty and corrected it and the firm has continued in the successful manufacture ever since.

In 1907 a graduate of Worcester Polytechnic Institute who had spent one year at the Massachusetts Institute of Technology came to Illinois as a research assistant. He completed his work for the degree of Ph.D. three years later and was continued as an instructor and later became assistant professor in charge of the division of organic chemistry. In 1916 one of the oldest of the firms manufacturing dyes in America searched the country over to find a man to organize their research laboratory. They selected this man, not because of any experience which he had had in industrial work, but because of his record as a research worker in pure organic chemistry and because of his ability to apply the principles of physical chemistry to this field.

Another young man, a graduate of Oberlin College and trained in research by Edgar F. Smith, of the University of Pennsylvania, came to Illinois in a subordinate position in 1907. During the eight or nine years following he became one of the leading workers in this country in researches upon the rare earths, and he was gradually advanced to the position of professor of inorganic chemistry. Two or three years ago he was asked by a firm in Chicago to assist them in the details of an important application of tungsten to an industrial use. He solved the problem and the result proved to be of large commercial value. Last year he was asked by the firm to organize a research laboratory to study the application of rare metals to industrial uses.

Another chemist who graduated at Illinois and afterwards took his degree of Ph.D. at Wisconsin is now state food commissioner of Illinois. There is not a man, woman or child in the state of Illinois who is not directly or indirectly dependent on this chemist for the maintenance of proper standards for the food which he eats.

Many similar illustrations of the importance of trained chemists might be given by any large university in America.

Such a laboratory as this has three important functions to perform. It must give an elementary knowledge of chemistry to many students who will not become chemists, but who yet should study the subject because chemistry touches the life of every one at many points. But this part of the work will be very poorly done if it merely imparts a set of so-called practical facts about every day life. Such facts will be quickly forgotten, but chemistry, better than almost any other science, furnishes a basis for clear scientific thinking and for students to acquire the habit of reasoning from one point to another in such a manner as to connect and combine their knowledge into a coherent, logical system. The discipline acquired in this way is of greater value than any set of facts that may be learned.

In the second place the laboratory will train a few men who will find their way into chemistry as a profession—it may be into some of the industries to which I have referred, or to become teachers, or to work

in our experiment stations over the important applications of chemistry to agriculture.

The third and most important function of the laboratory is the contribution which it makes to the growth of our science. Here in Oklahoma you have many problems which can be solved with the aid of chemistry. But just as Germany would have failed utterly to reach her highest achievements if her university professors had confined themselves to so-called practical problems, so this or any other university will fail if its staff does not devote a considerable part of its energies to the advancement of the science of chemistry quite irrespective of whether industrial applications for the results of their researches are apparent or not. No chemical laboratory has a right to call itself a university laboratory if it loses sight of this, the highest of its functions. A high-school may devote itself exclusively to teaching and a college may possibly do the same, though of that there is serious question. For the university there can be no question. Ours is a vital, growing, rapidly changing science and only those who are intensely interested in its growth can properly teach and inspire those who are to go out into the world and use for the advantage of themselves and of the state the training they gain in university halls.

William A. Noyes

MILITARY GEOLOGY

Modern warfare is a science, or rather an application of many sciences, and therefore it can afford to neglect no scientific field the cultivation of which would make for added superiority, in however slight degree. The usefulness of certain sciences to the carrying on of war is obvious or has been made so by the conditions of the European contest: such are surgery and chemistry; the military application of certain other sciences, however, is not so apparent and needs to be pointed out from within the subject itself: thus it is with geology. If the service that this science can render to the country in time of war be clearly established, then it follows that geology will be incorporated in our plan of military development and be called upon to do its proper part in furthering the military effectiveness of the nation.

This is a new rôle for geology, but a rôle already played and established in the theater of war in Europe. Military geology is a phase of applied science that has served the warring nations abroad; it sees many duties that it may perform for the United States.

In the first place, geological knowledge may be employed to advantage by an army in the field. "What a Geologist Can Do in War," is the title of a brochure prepared by R. A. F. Penrose, Jr., for the geological committee of the National Research Council and published in April, 1917. This short essay in scarcely more than a thousand words specifies clearly the varied service that a knowledge of geology can render, not only to the army in camp, but to the army on the march and in battle. The importance of this service may be judged by observing some of the problems arising in the course of field operations, which the geologist might appropriately be expected to solve.

The selection of camp-sites involves problems in drainage and sanitary arrangements, which become more difficult of solution in marshy country; in arid regions the possibility of disastrous cloudbursts destroying camps improperly located demands attention. Trenches and tunnels must be placed, so far as strategic conditions allow, in easily workable and drainable rock formations; while the stability of slopes depends upon the material in which the excavations are made. Ground for artillery positions should be selected not only from topographic considerations, but also in respect to the firmness and elasticity of the underlying rock, upon which the accuracy of fire will in part depend. The construction or repair of roads is a frequent military need, the more important because of the nec-

essity for transporting heavy artillery, for which the ordinary road-bed is inadequate.

Topographic maps carry a special meaning for the trained geologist while geological maps yield information of value in regard to the strategic quality of the country of advance; even without maps the geologist can draw inferences as to the ease and safety with which the country ahead may be traversed. The vibration effects of prolonged artillery fire in mountainous regions are likely to cause landslides and snowslides, which may prove disastrous if not anticipated and guarded against; but vibrations arising from the enemy's fire may be turned to advantage through seismographic records, showing the point of origin. Lastly, the question of an adequate water-supply is ever present, and the ordinary sources may often be enlarged or improved upon by the location of underground or artesian waters, while in deserts the avoidance or chemical improvement of waters too strongly alkaline becomes frequently of paramount importance.

In these respects, then, an army without geological knowledge is at a disadvantage; for the problems mentioned are all within the capabilities of the geological engineer and some of them must remain unsolved if geological advice is not at hand.

In the second place, an army employing geologists in its field activities can facilitate their effectiveness by maintaining a geological department at home for the accumulation of geological data and in particular of geological maps covering all possible regions of military activity. It is no small task to assemble such material in form and quantity suitable for use on short notice in any part of the world. Such a department, therefore, should be established in advance of field operations. A new type of map recently employed by physiographers, which shows by a block diagram both the topographic features and the underlying rock structures, would without question prove of distinct advantage to commanding officers planning a campaign or executing field manoeuvers. Few maps of this kind have ever been constructed; their preparation is slow and requires considerable skill and knowledge. It would fall within the province of the home office to develop the usefulness of this sort of map. The department also would appropriately assemble information on the water resources of regions of prospective occupation, so that the geologist in the field might be supplied with such results of previous geologic work, particularly in the enemy's country, as would facilitate his search for sources of water-supply.

A third way in which geology can contribute to the military strength of a country is through a study from a military standpoint of its mineral resources, the raw materials of war. In the United States, our mineral resources have long been the subject of organized investigation on the part of the Geological Survey, which has accumulated detailed and accurate information regarding them of the highest value at the present time. But the investigations of the Geological Survey have naturally been confined largely to the economic and scientific aspects of its field, and while much of its information can be quickly interpreted in terms of military necessity, the fact remains that this accumulated knowledge, much of it of the deepest military significance, has remained largely unused by military authorities, and the United States to-day is unprepared in respect to a few mineral products essential to war, such as nitrogen, potash, manganese, nickel, tin, and platinum. This country as a whole, however, is at a relatively efficient stage of preparedness in regard to her mineral industry, not because the government has studied and anticipated her military needs in this respect, but because recent economic demands have in most particulars been analogous to impending war demands, and hence the mineral industry under present economic conditions is largely on a military footing. But this does not obviate the desirability of a further military-geological study of our mineral wealth, for conditions are ever changing and we should anticipate every eventuality. In the future, the military importance of minerals is bound

to become of increasing significance with the approaching depletion of those resources most limited in quantity.

Finally the science of geology can be made of increased effectiveness in military activites through instruction of officers and military students in the elements of military geology. This may be acomplished at no great cost of time, by means of a brief and simple course of instruction given at military schools and training camps, supplemented by a manual which may be studied in the field. A knowledge of the properties and structure of the common rocks, and of the dependence of topography upon geologic conditions, would be of repeated usefulness to the officer and add to his efficiency. Some geological knowledge, at least, he must pick up in a practical way; its systematic acquisition might advantageously be made convenient for him.

Geology as a science is keenly alive to the military service it can render. Many of its members, its state and federal organizations, and its principal societies, are actively at work on plans for geologic research and the immediate application of geologic knowledge to the public welfare. But the most effective service can not come from individual or class initiative; it must await incorporation into the general plans of governmental organization, which to be effective will omit no advantage that any department of knowledge can give.

The problem facing the geologist, at the present moment, is not so much to apply his knowledge as to lead military authorities to see clearly the service that he is prepared to render.

Joseph E. Pogue
Northwestern University

SCIENTIFIC EVENTS

TUBERCULOSIS AND THE FRENCH ARMY

Dr. Herman M. Biggs of the New York State Department of Health, in the *Survey*, discusses tuberculosis in France as influenced by war conditions. According to a summary in the *Journal* of the American Medical Association he states that while practically all epidemic diseases which have heretofore been scourges of armies in the field have been brought under control in the present war, tuberculosis has assumed a large part in the sanitary history of the present struggle. France is the country that has been hard hit in this respect, though Biggs says that from such data as are obtainable Austria, Hungary, Russia, and perhaps to a less extent, Germany, have likewise suffered. As contrasted with England with 1 death from tuberculosis per thousand, New York State with 1.5, France before the war had 3 deaths per thousand, and in many cities the rate was higher. Biggs attributes this largely to the fact that even before the war France paid little systematic attention to tuberculosis. It had not been recognized by the sanitary authorities, and even now it is not a notifiable disease. With the advent of the war and the rapid mobilization of the troops, with examinations which were not sufficiently rigid, and with the strenuous conditions imposed on troops in the field, latent or arrested tuberculosis manifested itself among the troops, and by the end of December, 1915, 86,000 soldiers had been returned to their homes with active tuberculosis. In February, 1917, it was estimated that 150,000 had been returned for this cause. Biggs believes that in addition 3 or 4 per cent. of the population who formerly lived in the departments now in German occupation have the disease, which would mean another 125,000, based on a population of 4,250,000. Half of these live back of the German lines, partly in their own homes, partly in concentration camps and partly deported into Germany, many of whom have been returned on account of illness which made them a burden to their captors. Biggs says that while he was in Switzerland, of 20,000 of these people returned, 5,000 were said to have tuberculosis, though the estimated infection among those deported into Germany has been placed at 5 or 6 per cent., which Biggs believes is conservative. Among the 350,000 or 400,000 French prisoners in Germany an estimate of 5 or 6 per cent. of tuberculous infection has

been made, although some French estimates run as high as 30 or 40 per cent. Among the four million men in the active French army at present it is estimated that ½ to 1 per cent. have tuberculosis. It is not believed that the cases of tuberculosis among the civil population have decreased since the war, and in the remaining 30,000,000 not accounted for in the foregoing figures, on a conservative estimate, taking as a basis the prevalence of the disease before the war, there would be at least 150,000 cases, making in all about 500,000 cases, or, say, 400,000, to be extremely conservative, to be dealt with if the war were terminated at once. To deal with this vast number of cases Biggs says there are at present the so-called sanitary stations with 11,000 beds, which number it is hoped to increase to 16,000 by the end of the war, and a dozen or so well equipped dispensaries. There are practically no trained nurses or social service workers, but a few women are being trained in a three months' course in the Laennec Hospital. Not more than a dozen physicians are said to have given any special attention to tuberculosis, few have had sanatorium experience and still fewer are at all familiar with the tuberculosis work of others. The outlook, Biggs feels, is not encouraging, though the French government has partially realized the situation and is trying to meet the problem by the organization of dispensaries in the populous regions of France.

MEDICAL WORK IN BRAZIL

DR. GEORGE K. STRODE, a member of the International Health Board of the Rockefeller Foundation and who was one of the men sent to Brazil to make a study of medical conditions there, in a letter to Dr. David Riesman, which is quoted in *Old Penn,* writes in part as follows:

> The work of the International Health Board is in the hands of two of us down here. We have just completed an infection survey in the state of Rio de Janeiro, which has shown among 7,000 examinations for uncinaria a percentage of positives of 82. Malaria, I believe, is almost as wide-spread, and the two are a heavy drain on the people. Our work will shortly be extended to the states of Minas Geraes and São Paulo, which means the board will be busy in this country for a long time. At the present moment we are instituting an intensive campaign in one county of the state which will aim to cure and eradicate the disease in that area. This we hope will serve as a demonstration and will stimulate the authorities to continue the work.
>
> There are many diseases found here with which I am not yet familiar; most important are Chaga's disease (trypanosomiasis) and leishmaniasis. Tuberculosis is, however, more important than either of these and is being combated by voluntary organizations.
>
> Medical schools are government institutions, and the four leading ones are quite good. Six years are devoted to the course, the first two being almost wholly given over to pre-medical work. The graduate is not required to serve as an interne, so that only about 30 per cent. take such work. Indeed, in most of the hospitals internships are not available. Research laboratories are few and far between; the most noted is the Oswaldo Cruz Institute, which I visited last week. Much good work is produced here, but it is unfortunately very narrow in scope, entomology and parasitology being the only fields that are tilled.

RECOMMENDATIONS OF THE THIRD INTERSTATE CEREAL CONFERENCE

IN view of the world shortage of cereal food crops, which is likely to continue for an indefinite period, the Third Interstate Cereal Conference held at Kansas City, Mo., June 12–14, urges the greatest practicable enlargement of wheat acreage and would further make the following recommendations:

1. To encourage a larger wheat production, the producer should be guaranteed a minimum price, such price to continue at least one year after war is ended.

2. Early preparation of the land for small grains, where these do not follow cultivated crops, should always be practised. In the winter wheat area it is very important that this be done immediately after harvest.

3. Immediate action is required in providing seed for the next crop. At harvest time it is cheapest, and just before harvest seed in large bulk can best be selected. State and federal aid will be given in locating seed in localities of comparative abundance for use in localities where it is sorely needed. Clean seed, as free as possible from diseases, should be selected and arrangements be made for seed treatment.

4. Varieties of grain best adapted for the locality should always be used. The agricultural colleges and other state agricultural agencies will inform the farmers of the existence of these varieties and how and where to obtain the seed.

5. Every means should be employed to eliminate weeds, by use of clean seed, crop rotations, early cultivation above mentioned, and any special methods reliably recommended for particular weeds in different localities.

6. Seed testing for germination can well be further emphasized at this emergency period. The extension service, through county agents, should bring this matter home to every farm.

7. Seed treatment will largely prevent certain smuts and other diseases of cereals, and, as a real war measure, we are bound to see that it is applied as nearly as possible on every farm, thus increasing our cereal production a hundred million bushels or more, in one season. By field demonstrations the methods can and should be made plain to all concerned.

8. The possible ravages of Hessian fly, chinch bug, green bug, stored grain and mill products insects, etc., must be kept also in mind and the progress of and means of checking these insects be communicated, so far as possible, in advance of their local occurrence

9. As a means of reducing the great loss from rust, it is urged that all common barberry bushes (not the Japanese) and grass weeds harboring cereal rusts, be eradicated, and that rust-resistant cereal varieties be grown, if otherwise of good quality.

10. It is a conservative estimate that 20 million bushels of wheat and proportional quantities of other cereals are annually lost by waste in harvesting and thrashing. This waste can and and should be, in large measure, easily avoided. A man and team are known to have cleared $27 to $62 a day from cleaning up after thrashers, and, in another instance, last year in Kansas, $500 was gained by a man, with a team and fanning mill, cleaning up after thrashing machine settings, in three weeks' time.

11. In the western and southwestern plains, grain sorghums should be widely planted. In the northern plains, in the drier districts, flax and, under certain conditions, proso or Russian millet, may be used to a similar advantage.

12. Suitable catch crops (such as cowpeas, soy beans, sorghums, millet, flax and buckwheat) should be grown on all lands on which staple crops can not be seeded at the proper time or on which they have been destroyed.

13. The increased use of corn, rice, grain, sorghums, proso, barley, rye, beans, cottonseed meal and peanut meal as substitutes for, or in conjunction with, wheat for human food is strongly recommended. Information on this matter can be obtained through the state agricultural colleges and the United States Department of Agriculture.

ORGANIZATION OF THE ENGINEERING COUNCIL

On June 27 was held the first meeting of the Engineering Council. This body is a department of the United Engineering Society and has recently come into being as a medium of cooperation between the four national engineering societies. The function of the council may perhaps best be described by the following extract from the by-laws of the United Engineering Society:

> The council may speak authoritatively for all member societies on all public questions of a common interest or concern to engineers.

The council is composed of twenty-four members, five being appointed by each of the four founder societies and four by the United Engineering Society. Its present membership follows:

American Society of Civil Engineers.—J. F. Stevens (Chas. Warren Hunt), George F. Swain, F. H. Newell, Alex. C. Humphreys, F. D. Galloway.

American Institute of Mining Engineers.—P. N. Moore, S. J. Jennings, B. B. Lawrence, J. Parke Channing, Edwin Ludlow.

American Society of Mechanical Engineers.—I. N. Hollis, Chas. Whiting Baker, John H. Barr, A. M. Greene, Jr., D. S. Jacobus.

American Institute of Electrical Engineers.—H. W. Buck, E. W. Rice, N. A. Carle, P. Junkersfeld, C. E. Skinner.

United Engineering Society.—Clemens Herschel, B. B. Thayer, I. E. Moultrop, Calvert Townley.

At the organization meeting held in the rooms of the American Society of Mechanical Engineers at 2.30 o'clock P.M., on the twenty-seventh instant, the following officers were elected:

President: I. N. Hollis.

Vice-presidents: H. W. Buck, George F. Swain.

Secretary: Calvert Townley.

Executive Committee: The four officers named, with J. Parke Channing and D. S. Jacobus.

The council discussed at length ways and means by which the founder societies through the council may be of use to the nation. The unanimous desire to help the government in the prosecution of this war resulted in a resolution instructing the executive committee to cooperate with the government in procuring the services of engineers, also the appointment of a committee of three consisting of Messrs. H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby, to consider the best means of utilizing the inventive ability of members of the founders societies.

The secretary was instructed to inform all government bureaus that might be interested in the organization of the Engineering Council and its desire to be of assistance.

SCIENTIFIC NOTES AND NEWS

THE Index to Volume XLV. of SCIENCE is published with the present issue. It is sent to libraries and to those who have requested that copies of the index be sent regularly. It will be sent to any subscriber on application.

THE degree of D.Sc. has been conferred by Williams College on Robert Grant Aiken, '87, since 1895 astronomer at the Lick Observatory.

AT its ninety-sixth annual commencement the George Washington University conferred its doctorate of science on George Perkins Merrill, of the U. S. National Museum; on Elmer Ernest Southard, of the Harvard Medical School; on Arthur Powell Davis, of the Reclamation Service, and on Frederick Fuller Russel, major, Medical Corps, U. S. Army.

THE University of Arkansas has conferred its doctorate of laws on the governor of the state, Charles H. Brough, who before his election was professor of economics and sociology in the university.

SIR DAVID PRAIN, director of the Kew Botanical Gardens, has been elected president of the Linnean Society.

ALFRED H. BROOKS, formerly in charge of the Division of Alaskan Mineral Resources of the U. S. Geological Survey, has been appointed a captain in the Engineer Officers Reserve Corps and ordered to report for training. During Mr. Brooks's absence on military duty, Mr. George C. Martin will be geologist, acting in charge of Alaskan work.

WE learn from *Nature* that Mr. J. Ramsbottom, of the department of botany, British Museum, has been appointed protozoologist to the medical staff at Salonika. The trustees of the museum have accepted Miss Lorrain Smith's offer to act as temporary assistant in charge of the fungi during Mr. Ramsbottom's absence.

MISS AMY WALKER, M.A., Smith College, has been appointed research assistant in the chemistry of foods, Massachusetts Institute of Technology, under the Ellen H. Richards Fund, for the year 1917–1918. The work will be carried on under the direction of Professor A. G. Woodman, and it is proposed to study chemical changes, with special reference to the nitrogen compounds, which take place when fish decomposes before and after heating at relatively high temperatures. This question is of particular interest in the sardine industry.

SIR ERNEST SHACKLETON has now returned to England, after lecturing in Australia and America. He has received a commission in the army.

PROFESSOR JOSEPH S. AMES, of the Johns Hopkins University, who was sent to France early in April under the auspices of the Council of National Defense, has returned to Baltimore. Professor Ames will report on the development of aeronautics.

DR. H. D. DAKIN, who was appointed last March, with Dr. Alexis Carrel, to have charge of the military hospital which is being constructed and equipped by the Rockefeller Foundation on the grounds of the Rockefeller Institute of Medical Research, has returned to New York. Dr. Dakin went over to France in April to consult with Dr. Carrel, with whom he worked during 1915 and 1916 as a bacteriologist.

THE Linnean Society, London, has presented the Linnean gold medal to Mr. H. P. Guppy for his services to biology, and the

Crisp medal to Dr. R. J. Hilliard, of the University of Sydney.

Dr. J. M. Coulter, head of the department of botany, University of Chicago, delivered the annual Phi Kappa Phi address at the Kansas State Agricultural College on May 15. The subject of Dr. Coulter's address was "Science and the public service."

Dr. Frank Waldo, of Cambridge, formerly professor in the U. S. Signal Service, has volunteered a series of eighteen lectures on meteorology to the men at the Squantum aviation camp of the Massachusetts Institute of Technology.

Professor H. H. Bartlett, of the University of Michigan, has given, during the week of May 21–26, a series of five lectures, under the auspices of the department of plant breeding, of Cornell University. The topics of the lectures follow:

Elementary and collective species in nature.
Evidences of mutation in plants and animals.
The behavior of mutations and elementary species in inheritance.
The critics of the mutation theory.
The most recent investigations of variation and heredity in *Œnothera*.

M. Emil Boutroux, professor of philosophy at Paris, has been appointed Herbert Spencer lecturer at the University of Oxford for the present year. A Romanes lecturer at the university has not been appointed, the income having been transferred to the emergency relief fund of the university.

Mr. Stephen Paget is preparing a biography of the late Sir Victor Horsley, the distinguished English surgeon.

Dr. Bert H. Bailey, since 1900 professor of zoology at Coe College, died on June 22, aged forty-two years.

Dr. Joseph Weinstein, an instructor in chemistry at Columbia University, died recently in the laboratory of the university. He was fifty-five years old, an analytical chemist and was graduated from the College of Physicians and Surgeons, Columbia University.

Sir William D. Niven, F.R.S., formerly director of studies at the Royal Naval College, Greenwich, died on May 29, at the age of seventy-five years.

Dr. William Henry Besant, F.R.S., fellow of St. John's College and lecturer on mathematics, died on June 2, in his eighty-ninth year.

The annual meeting of the Society for the Promotion of Engineering Education will be held in Washington, D. C., on July 6 and 7 in connection with the educational committee of the advisory commission of the Council of National Defense, instead of in the northwest as formerly planned. The topic which will be discussed at this meeting is "The relation of the engineering school to the national government during the present emergency." F. L. Bishop is secretary of the society.

Captain Robert A. Bartlett, on June 30, telegraphed to the American Museum of Natural History from St. Johns, Newfoundland, that he had taken command of the steam sealer *Neptune* at that port, and that early on July 1 he would steam for Sydney, C. B. The eight tons of supplies shipped from New York for the Crocker Land party are at Sydney and will there be stowed on the *Neptune*. Captain Bartlett expects to leave Sydney on either the third or fourth of July for Etah, Greenland, where the Crocker Land Expedition is now quartered. Coincident with the leaving of the *Neptune*, a special display devoted to the Crocker Land Expedition has been installed on the first floor of the American Museum of Natural History. The location of the expedition, as well as the probable course of its return, is indicated on a globe. This exhibition also includes pictures of the vessels which have been sent to the rescue of the party—the *Neptune* being the third. There is also on view a canoe of skin, the kyak, in which Dr. Harrison J. Hunt, a member of the party, who arrived a few days ago, made part of his perilous journey from the base at Greenland to civilization.

The government of the Union of South Africa has appointed an advisory board to deal with the development of the natural resources of the country. A special scientific and technical committee has been appointed to carry

out scientific investigations. This committee consists of Mr. J. Burtt-Davy (botany and agriculture); Mr. L. Colquhoun (chemistry); Professor Young (geology); Professor Orr (mechanical engineering); Mr. Bernard Price (electrical engineering); Professor Beattie (physics); Dr. Caldecott (metallurgy); Professor van der Riet (chemistry); Professor Malherbe (chemistry); Dr. L. Peringuey (president of the Royal Society of South Africa). The first step taken by the new committee has been to arrange for the preparation of fifty-two reports by leading experts, dealing with the available raw materials of South Africa suitable for manufacture or export. It is intended that these reports shall be published for the guidance of intending manufacturers and other business men.

ARRANGEMENTS have recently been completed for the establishment of a new department of technical optics in connection with the Imperial College of Science and Technology at South Kensington. According to a statement in the London *Times*, the new department is under the management of a Technical Optics Committee, of which Mr. Arthur H. D. Acland is chairman, and which at present consists of 13 members representing the Admiralty, the Army Council, the Ministry of Munitions, the Royal Society, the National Physical Laboratory, employers in the optical trades, glass manufacturers and the Imperial College; while two further members have yet to be elected representative of glass workers and metal workers. Mr. Frederic J. Cheshire has been appointed head of the new department at the Imperial College for a period of five years, with the title of director of technical optics and professor of technical optics at the Imperial College. Mr. Cheshire has been associated with optical instruments for many years at the Patent Office, and, since the formation of the Ministry of Munitions, has been deputy director-general of the ministry and technical director of the optical department. He is president of the Optical Society. It is anticipated that the organization of departments will be rapidly completed, and that training will begin at an early date.

UNIVERSITY AND EDUCATIONAL NEWS

PLANS for medical work at the University of Chicago, for which a fund of $5,500,000 has been raised, contemplate two medical schools and provision for research. One medical school on essentially the same basis as that of the Johns Hopkins University is to provide training for candidates for the degree of M.D. The other school, in connection with the Presbyterian Hospital, is intended for the benefit of those in actual practise. It may be estimated that the entire amount of money involved, including all the corporations which unite for this work, will reach approximately $15,000,000.

MR. LEVI BARBOUR, of Detroit, has given $150,000 to the University of Michigan, one hundred thousand dollars of which is to be used for a residence hall for women and fifty thousand for scholarships for women from oriental countries.

As the result of recent gifts, Lawrence College, Appleton, Wis., is erecting a dormitory for women to cost $125,000 and a chapel to cost $120,000.

DR. JESSE MORE GREENMAN, associate professor in the Henry Shaw School of Botany of Washington University and curator of the herbarium of the Missouri Botanical Garden has been promoted to a professorship of botany in Washington University.

AT the recent commencement of Syracuse University, Dr. Louis M. Hickernell was promoted from an instructorship to be assistant professor of zoology. Mr. Harry S. Pizer, B.Sc., won a teaching fellowship in zoology for the coming year.

DR. A. E. SHIPLEY, master of Christ's College, Cambridge, and reader in zoology in the university, has been elected vice-chancellor for the next academical year.

DISCUSSION AND CORRESPONDENCE

AN INSTITUTE FOR THE HISTORY OF SCIENCE AND CIVILIZATION

TO THE EDITOR OF SCIENCE: Dr. Sarton's plan for an *Institute for the History of Sci-*

ence and Civilization is one of the most important and fruitful suggestions that have been made for the advancement of knowledge. It is to be hoped that the realization of his idea might come soon and not have to wait until that rather indefinite time—"after the war." As Dr. Sarton very properly points out, it would be particularly important and fitting if this institute would be founded in this country *at this time*. That the United States, since he wrote his communication, has entered the war should make no difference. We are, as I understand it, fighting for internationalism and the founding of the institute now would emphasize the international spirit of American science.

What most particularly interests me in Dr. Sarton's plan is the place he gives to Bibliography. Some readers of Science will perhaps remember a couple of communications that the present writer sent to this journal, now many years ago, on the subject of a proposition for an *Institute for Bibliographical Research*. The two ideas should be combined. A third idea might perhaps be added to this combination, namely the plan for a lending library for libraries, consisting of large and expensive works, chiefly periodicals, transactions and collections, just the kind of publications that the Institute would need for the proper carrying on of its researches; that the collections of such a library would have to be made available to students all over the country should make no difference; it would emphasize the national character of the Institute.

Now, as to Bibliography, one of the first duties of the Institute would be to prepare an adequate and, as far as possible, complete bibliography of the history of science. The "List of Books on the History of Science," with its Supplement and its companion "List of Books on the History of Industry," published by The John Crerar Library, is merely a bringing together of the material, and only part of the material, for such a bibliography. Furthermore, bibliographical research must be one of the principal methods of study in the institute. There should be a separate, specially organized, division for Bibliography, the function of which should be not only to carry on bibliographical research and publication, but to give those who come to the institute what they do not seem to get in American universities, a much needed training in the technique of bibliographical compilation and recording. It is not uncommon to find otherwise well equipped scholars totally incapable, apparently, of making bibliographical references in a consistent and systematic way, though thoroughly familiar with the bibliography of their subjects and its byways. Those who are interested in a few examples, will find them in an article by the present writer in volume 7 of the Papers of the Bibliographical Society of America, entitled "Efficiency and Bibliographical Research."

Aksel G. S. Josephson
The John Crerar Library

POPULAR NAMES OF PLANTS

To the Editor of Science: My attention was recently called to an article in your issue of February 2 concerning popular names of North American plants. I especially noted the following sentence:

> It is clear, however, that pupils in the public schools, as well as many of their teachers, do not take any interest in or remember the Latin names of plants. This being so, it is highly desirable that every species of plant inhabiting the United States and Canada should have an English name. It is further desirable that the name should not be a local one. . . .

Several years ago when acting as editor-in-chief of *The Nature-Study Review*, I took interest in this question of popular names of plants and discussed it with many competent teachers of nature-study. I was forced to the conclusion that in a large number of cases it is possible and highly desirable that we should make the English out of the generic names. It is my observation that children learn these names quite as easily as they do English names with which they are not already familiar. It is nonsense to claim that children can not learn scientific names, for example, chrysanthemum and hippopotamus. As examples of familiar plants which are very generally known by their scientific names or

by slight modifications thereof, I cite the following list: cosmos, centaurea, aster, alyssum, ageratum, dahlia, canna, petunia, portulaca, primula (primrose), salvia, verbena, zinnia, impatiens, rosa (rose), gaillardia, heliotropium (heliotrope), lobelia, lilium (lily), magnolia, hyacinthus, chrysanthemum, anemone, oxalis, wistaria, clematis, iris, spirea, pæonia (peony), forsythia, phlox, gladiolus, begonia, asparagus, arbutus, coreopsis, smilax, trillium, viola (violet), geranium, fuchsia, tulipa (tulip), catalpa.

The suggestion that a species of *Erechtites* be called white fireweed and one of *Epilobium* be purple fireweed shows the absurdity of trying to standardize local names, for there are white species of *Epilobium*. I am sure that it is easier for school children to learn this scientific name qualified by white or purple.

There are some interesting popular confusions of scientific terms, *e. g.*, syringa is a popular name but unfortunately has become attached to mock orange (*Philadelphus*) instead of correctly to lilac, which as an English name has been applied to various kinds of shrubs.

M. A. BIGELOW

QUOTATIONS

TECHNICAL COLLEGE GRADUATES IN WAR TIME

ONE of the first effects of the entry of America into the war has been the volunteering of the graduating classes, nearly en masse, throughout the country, into national defense service, with a considerable number of enlistments also in junior classes. This dedication of our trained youth for the maintenance of justice against brute-strength aggression is an admirable thing, and no one who believes in the ideals of young men will oppose it. It is important to remember, however, that injudicious dedication to the world's good may actually do the world harm, and well-intended action may by over-haste defeat its own purpose.

War is a vast country-wide engineering enterprise. Theoretically speaking, an all-wise and powerful board of experts should determine where each man and woman should be posted in the great war chain of fighters, for it is obvious that all specially trained men, and particularly all technically trained men, should keep at the posts where their training is needed. It was an inevitable mistake made by our allies at an earlier stage in the war which led many young physicians, engineers, mechanics and valuable specialists to rush as volunteers for the front. It may overtax human intelligence to decide whether any particular man of military age is more needed at the front or at the rear. Mistakes must occur, and many of them; but the technically trained men should be kept at their profession unless there happens to be a superfluity of them. So long as there are earnestness and determination to serve, they also serve who only stand and wait. The junior men in colleges, and particularly in technical or medical colleges, will probably serve their country better by working hard at their educational preparation than by abandoning their college work before their training is completed. In general, however, every day's work done in any sort of productive employment contributes to the war and therefore hastens the end of the war. To do any useful thing hard is to fight for the Allies.—*The Electrical World.*

DISCOVERIES AND INVENTIONS

THE fact can scarcely be reiterated too frequently that the government should extend patronage to scientific investigations and mechanical inventions. Such a step is necessary to promote the arts and industries as well as to safeguard the nation in war. The United States can no longer proceed on a policy of bungling and neglect. Even the Naval Consulting Board is inadequate to the needs of the present emergency. The ability of its individual members is high, but the number of problems to which the board can give its attention is limited by the restricted membership.

The problems taken up by these most competent experts are undoubtedly the most urgent, but even on these particular problems

the country is not receiving the benefit of all of the ideas worth considering. Independent inventors are reluctant to contribute the fruits of their efforts through a board whose members are identified with large industrial concerns. Unfortunately the sad story of the inventor who receives no compensation for his discoveries is only too well known. He lacks the means for proper experimentation, as well as for manufacture, and to obtain aid of the capitalist he has to mortgage his prospects too heavily.

A correspondent has suggested that prizes should be offered to stimulate individual enterprise, but only investigators having private means would be in a position to compete for such prizes. It would be a better plan for the government to offer scholarships and to maintain extensive research laboratories and shops where experimental work could be done on a large scale. The work of thousands of inventors is entirely wasted not only because of duplication, but because they are compelled to abandon their investigations after making some discoveries of more or less potential value. If records of their work were preserved a new epoch in the advancement of science might be inaugurated.

On April 2, W. H. Fauber, of Brooklyn, addressed a paper to the board of governors of the Aero Club of America advocating the creation of a government board of invention and research in aeronautics. He also called attention to the fact that it takes so long to adjudicate a patent that the inventor is apt to die during the process, and that an invention really is not protected unless it is in the hands of a powerful corporation.—The New York *Evening Sun.*

SCIENTIFIC BOOKS

BOOKS ON FOOD

William M. Bayliss, the celebrated English physiologist, has written a small volume entitled "The Physiology of Food and Economy in Diet" (Longmans, Green and Co., 1917). In a hundred pages he presents in clear, concise and fascinating language the fundamental principles of nutrition. Bayliss, though noted for his work on the secretory glands and not recognized as an expert on nutrition, has nevertheless written with the appreciative touch characteristic of the master mind.

Miss Winifred Stuart Gibbs, the supervisor of home economics of the New York Association for Improving the Condition of the Poor, has made a valuable contribution to the food problem in "The Minimum Cost of Living" (The Macmillan Co., 1917). The income and expense accounts of seventy-five families receiving charitable aid, in the form both of advice and of money, were analyzed. A food allowance made up from twenty-two items in quantities calculated to suffice for the maintenance of the family, as constituted, gave very successful results. The author states: "Any one who has had experience in working with the tenement population knows how intimate a connection exists between food and the more common diseases of poverty." Thus, before the allowance was granted, record after record read, "children anemic," or "mother suffering from malnutrition." But the allowance of a minimum standard laid the foundation of good health. "Such a sum can restore shattered nerves and renew courage for a mother who has been harassed by irregular and uncertain payments of an income inadequate at best. Such an assured minimum can change pale, listless children into rosy-cheeked romping boys and girls." The "unit" of value for food per "man" per day was taken at 3,000 calories and cost on October 1, 1916, thirty-four cents. Children were rated according to their ages at various fractions of a "man." These latter values appear to be minima. The book tells of an inspiring deed of good work.

Another book, "Food for the Worker," by Miss Frances Stern and Miss Gertrude T. Spitz, with a foreword by Lafayette B. Mendel (Whitcomb and Barrows, 1917), should fill a great need at the present time. In this volume are found 120 household receipts, with their food values, and the arrangement of these recipes into different menus of balanced rations for use during a period of forty-nine days or seven weeks. It should be of aid to any economical housewife, although it aims specifically

to designate the food requirement of a family of five, containing three children whose ages are between eight and sixteen. The diet provides 12,500 calories, contains 375 grams of protein, and cost one dollar and six cents per day in July, 1916. Of this, twenty-four per cent. was spent for bread, thirteen per cent. for milk, fifteen per cent. for meat, and the rest for seventy other articles. The bread ration contained 4500 calories or 35 per cent. of the total energy value of the food. This kind of information is of highest value to the housewife of limited means and can be successfully applied by any intelligent person.

"The Mothercraft Manual," by Miss Mary L. Read (Little, Brown and Company, 1916), presents, in language which is a delight, modern as well as old world knowledge helpful in the creation of the best environment for the family and describes the care, nutrition and development of the child.

GRAHAM LUSK

SPECIAL ARTICLES

THE THEORY OF SEX AS STATED IN TERMS OF RESULTS OF STUDIES ON PIGEONS[1]

AT the 1911 meeting of this society, in Princeton, I first made known the fact that the sex of pigeons had been experimentally controlled by Professor Whitman. The main fact of method being briefly that from a family cross practically only males, and from a generic cross nearly all males, are produced; but if, by special means the birds of generic crosses are forced to excessive reproductive overwork then the earlier eggs of such a series produce mostly or only males, while the later eggs—from the end of the series—will produce mostly or only females. At the same time and place I made to this society a first report upon the nature of the results of my own studies upon the ova of some of these sex-controlled series. These results then indicated—to quote from the published abstract of that paper[2]—

[1] Paper read December 28, 1916, before the American Society of Zoologists (New York Meeting).

[2] SCIENCE, N. S., Vol. XXV., No. 899, pp. 462–463; March 22, 1912.

that eggs (yolks) of *smaller size, higher water-content* and *smaller energy-content* (*i. e.*, fewer units of physiologically available energy) can be *correlated* with *maleness* in the offspring. That eggs (yolks) of *larger size, lower water-content* and *greater energy-content* can be *correlated* with *femaleness* in the offspring.

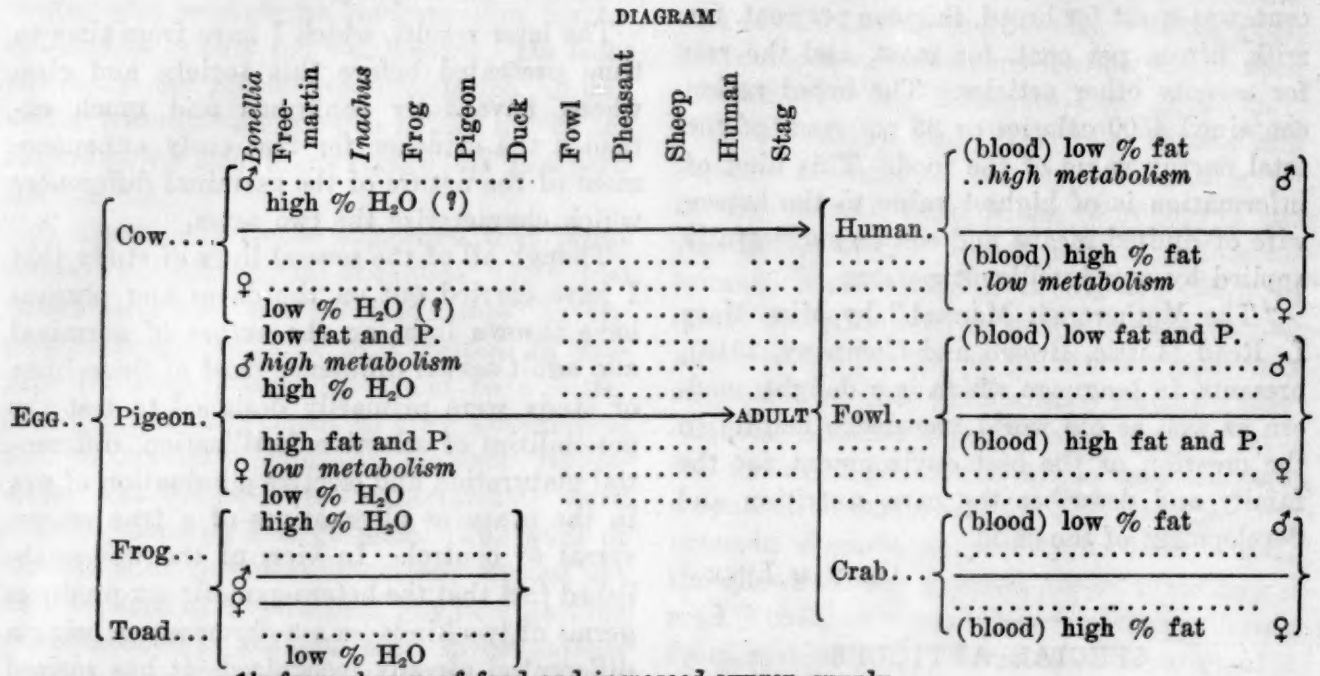
The later results, which I have from time to time presented before this society and elsewhere, have fully confirmed and much extended the evidence for that early announcement of the nature of the germinal differences which characterize the two sexes.

Though all of the several lines of study that I have carried out on the doves and pigeons have thrown light on the *nature* of germinal and adult sexual difference most of these lines of study were primarily designed to test the possibilities of selective fertilization, differential maturation and elective elimination of ova in the ovary as alternatives of a true sex-reversal or control. In view of the well-established fact that the hetero-gametic sex produces germs of two kinds—a sex-chromosome being a differential already recognized—it has seemed obligatory to supply decisive tests for the possibilities just named. This has all been thoroughly done in the pigeons; the result has been made possible because the female here is the hetero-gametic sex, producing male and female ova, and we have here learned to identify each of the two kinds. In these forms Whitman controlled sex and clearly demonstrated the methods of control. In these same forms I have for six years repeated the control and fully confirmed the method. In addition I have obtained adequate proof of the reality of the sex-control as against the above-mentioned alternatives and have further shown that in this material sex is a matter of essentially *all* gradations. And, of signal and unique importance is the fact that all, or at least many, gradations of sex are obtained from the same pairs of parents. The *outlines* of these findings have been published in several short papers beginning in 1911;[3] the entire body of evidence

[3] See under note 2; and, Carnegie Year Book, 1913; SCIENCE, Vol. 39, 1914; *Bull. Amer. Acad. of Med.*, Vol. XV., 1914; *Amer. Nat.*, Vol. L., July, 1916.

is now in course of preparation for publication. A still further fact of high importance has been learned from the pigeons, namely, that the sexual differences of the germs persist into the adult stages of the two sexes.

DIAGRAM



Again, since my first report of these results, several studies by other investigators on several different groups of animals, have appeared which in a most gratifying manner confirm the point of view of my first communication, and afford further evidence for the control and modifiability of sex.

It is the purpose of this paper to arrange some of the results of studies on the pigeon in a diagram, upon which are properly placed these various results of other investigators of sex, in order to show that we are already in possession of the skeleton of fact which is necessary for a theory of sex that accords with the most important fact of sex-reversal and control. And, that the theory of sex must be restated—or rather may now be stated—in terms that accord with the facts of sex-reversal is as certain as is the fact of sex-reversal itself. After our demonstration of the reality of sex-reversal in doves and pigeons—even there had been a complete lack of corroborative evidence in other forms—the problem of the ultimate basis of sex was effectively broken loose from the morphological moorings which a decade of increasing knowledge of the sex-chromosomes had, to a considerable extent, fastened it. For, at the same time that it was proved that our *experimental* conditions break the correlation which *normally* certainly does obtain between the chromosomal constitution of the zygote and the prospective sex of the adult, it was possible to identify those *functional* correlations which here continue to exist (as in the normal cases) and mark off the differences between the germs of prospectively different sex-value. We know, till now, of no other material in which this basal persistent function has been definitely identified and quantitatively measured in the germ. As I have elsewhere pointed out, the basic fact is that the two kinds of germs are differentiated by the degree or level of their metabolism. When either of these two kinds of germs is forced experimentally into the production of the opposite sex, the level of its metabolism is shifted to the level characteristic of the germs of that oppo-

site sex. While the chromosomal correlation is here forced to failure the metabolic correlation here persists. The chromosomal constitution is not an efficient cause of sex; it is but a sign or index[4] and possibly an assistance in the *normal* maintenance of that which is essential—namely, two different metabolic levels. But the requisite metabolic level of the germ may be established in the absence of the usual or appropriate chromosome complex, and the sex of the offspring made to correspond to the acquired grade or level of metabolism.

These facts which we consider firmly established in the pigeons carry the further *essential* analysis of sex practically into the field of physiology and bio-chemistry. Further analysis of the basis of sexual difference—in germ or in adult—is to be sought in studies of the metabolic differences of the two kinds of sex-germs, of adults of the two sexes, and of individuals of intermediate sex. Now that the problem of sex has been shown to belong in the field of metabolism we shall be able to note, in connection with our diagram, that a number of the requisite data bearing on germinal and adult sexual differences are already at hand.

Turning now to the diagram we note that *egg* and *adult* stages are considered. In the egg of the pigeon we have identified maleness and femaleness by three differentials. Femaleness in the egg stage being accompanied by *low metabolism,* lower percentage of H_2O, and higher total fat and phosphorus, or of phosphatides. Maleness is here accompanied by *high metabolism,* higher percentage of water, and lower total fat and phosphatides. Now there are valid reasons for treating these three differentials not as absolutely separate and disconnected facts, but rather as aspects or corrollaries of the same fact. For example, a *high metabolism* in a cell is consonant with less storage of fat and phosphatides, and with a more highly *hydrated* state of the cell-colloids. It follows that where data for either of these three differentials are at hand, for either the germ or adult of any animal, we have in such data evidence of the kind we are looking for, *i. e.,* evidence for the association of a given type of metabolism with the germ or adult of a given sex.

TABLE I

Sexual Differences of Fat and Phosphorus in the Blood of Adult Fowls and Man

Sex	Av. Total Fat	Av. Total P.	Ratio P.
Males (roosters)	15.45	6.43	100
Non-laying females	17.87	7.42	115
Laying females	27.80	13.15	205
Males (man)	141.4		
Females (woman)	226.0		

For what forms then are such data available? And, what is now known of the persistence of this definite type of differentiation of the two kinds of sex-germs into adult stages of the two sexes? Recently Lawrence and Riddle[5] have shown that one of these differentials—or one aspect of *the* differential which my own work has demonstrated in the egg—is clearly continued in the *blood* of the adult male and female (see Table I.). Fowls were substituted for doves in this case in order to increase the size of the sample, and thus increase the accuracy of the analytical results. In birds, therefore, we have fairly clear evidence that the metabolic differences of male and female germs persist in the male and female adults. In mammals too these aspects of sexual differences of the adults have been fully demonstrated. Almost simultaneously with the above determinations, data were published by Goettler and Baker,[6] which as we have pointed out, show that the blood of the human male contains less fat, that of the female more.[7] Further, the *basal metabolism* of the human male and female has recently been accurately

[4] Since the chromosomes are *structural* characters they can not be expected readily to *alter* their numbers, etc., in response to new quantitative levels attained (permanently) by the fundamental *cell-functions.*

[5] "Sexual Differences in the Fat and Phosphorous Content of the Blood of Fowls," *Amer. Jour. of Phys.,* Vol. XLI., September, 1916.

[6] *Jour. Biol. Chem.,* XXV., June, 1916.

[7] This result seems to have been anticipated by Gorup-Besanez in 1878.

determined by Benedict and Emmes;[8] they find that the metabolism of man is 5 per cent. to 6 per cent. higher than that of woman.

Have we any measure of either of our differentials in any mammalian egg? I think that the experiments on sex-determination in cattle, together with an observation by van der Stricht, afford some evidence that the water-content of the male-producing egg is high, and that of the female-producing egg is low. Thury reported in 1862 that from fertilizations made in the early period of heat in cattle an excess of females were produced; and that later (delayed) fertilizations give rise to an excess of males. Similar experiments have been four or five times repeated by others, and these have all shown an excess of one or the other sex in accordance with such early or late fertilization.[9] No one definitely knows whether the ovum of the cow absorbs water in the Fallopian tubes in this interval between ovulation and fertilization, but we do know that every amphibian, reptilian and avian egg that has been investigated does absorb very appreciable amounts of water while being passed from the ovary to the exterior. And, van der Stricht has described phenomena of growth or swelling of the yoke granules in one mammal—the bat—which, I am sure from my own studies on yolk, indicate the taking up of water by the egg of this mammal. It is highly probable, therefore, that precisely that *time relation* which leads to an excess of males in cattle is preceded or accompanied by an increased hydration of the ovum. In mammals therefore there is some evidence that a shift of the metabolic level—as indicated by one partly known sex-differential—is associated with the observed changes in the sex-ratio of the germs which are thus modified. Further, in one adult mammal—man—two of the three sex-differentials have been definitely demonstrated. These results for both the egg and adult stages of the mammal are at every point in complete agreement with our data for both the egg and adult stages of the bird.

Experiments on the frog and the toad have afforded evidence for the control of sex. This evidence by many is not thought conclusive. Though selective fertilization has been eliminated as a possibility by Kuschekewitch there remains the possibility of parthenogenetic development to account for the excessive male-production in his experiments with the frog. But this appeal makes it impossible to explain the great excess of *females* obtained by Dr. King on the eggs of the toad, and leaves such doubters to lean here upon the discredited staff of selective fertilization—a proposition wholly disproved for the related frog and for the pigeon.

How does this situation look in the light of the sex-differentials already noted for birds and mammals? Richard Hertwig,[10] and later Kuschekewitch,[11] allowed frog's eggs to over-ripen—a process during which *the eggs take up water*—and obtained (in the case of the latter author) in some cases a total of 100 per cent. of males. Dr. King[12] did the converse of this experiment with toad's eggs—*withdrawing water* from them before fertilization—and obtained nearly or quite 90 per cent. of females in cases where the mortality was less than 7 per cent. According to our knowledge of the sex-differentials in the pigeon's eggs both of these experiments might have been predicted to result as these three investigators have reported.

In the spider-crabs Geoffrey Smith[13] has shown that both the blood and the liver of the adult male crabs contain less fat than do the blood and liver of the females. Here once more the facts concerning one of the sex-differentials is in complete accord with all the preceding cases. In the parasitically castrated spider-crabs Smith and Robson were able to show, moreover, that *the parasitized male crabs, which under these conditions gradually assume several female morphological character-*

[8] *Jour. Biol. Chem.*, Vol. XX., 1915. These authors give references to earlier literature.

[9] The use of the terms *early* and *late* fertilizations assumes that some ovulation occurs either immediately before, or shortly after, the beginning of heat.

[10] *Verhand. deutsch. zool. Gesellsch.*, 1906.

[11] *Festschrift. f. R. Hertwig*, 1910.

[12] *Jour. of Exp. Zool.*, Vol. 12, April, 1912.

[13] *The Quart. Jour. of Micr. Sci.*, Vol. 57, November, 1911.

istics, are also found to have assumed the type of fat metabolism which characterizes the normal female crab. How much these facts contribute to, and how completely they adjust themselves to, our own general theory, will be realized only after a moment's reflection.

A glance at the diagram indicates three other groups of animals which experimental work has thrown into the general question of the control of sex. The information at hand for these forms does not so expressly concern the *egg* as does that from the preceding cases, but all of these latter groups are concerned with early stages—some of them with the generation preceding the egg whose sex seems influenced by conditions. The results of studies of the first of these groups—*Hydatina*—are of such a kind as to show that they are in general accord with the metabolic differentials of all of the previously mentioned cases of sex-control. One can scarcely doubt that *change* of food, and *increased oxygen* supply are consonant with increased metabolism, just as the studies of Whitney[14] particularly, and later of Shull,[15] have shown that these changes lead to the appearance of male-producing daughters.

The second of these groups—the Daphnids—have been studied by three independent investigators who agree upon two points that are of importance in the question of the control of sex, and to the general theory of sex as stated here, though the results throw little light on precisely what is causally involved. Issakowitch,[16] Woltereck[17] and Banta,[18] all find numerous *sex-intermediates* in a material for which all agree that the type of reproduction—sexual or asexual—is influenced by environmental conditions. All further agree that "unfavorable conditions" (or is it a *change* from favorable conditions?) tends toward *sexual* reproduction, while "favorable conditions" favor asexual reproduction.

In the third of these groups—the moths—the studies of Goldschmidt, and Goldschmidt and Poppelbaum,[19] and the work of Machida, have demonstrated again sex-intermediates of various grades. Moreover, it has been shown that from among the various geographical races of moths certain matings can be arranged which produce rather definite types of male- or female-intermediates—or sex-intergrades, as Goldschmidt elects to call them. And further, from pairs involving still other species still other levels or grades of sex-intermediates may be freely obtained. A more or less factorial basis of the phenomena has hitherto been used in the discussion of these results; but recently Goldschmidt[20] has stated that "very important new facts will be published later which will probably enable us to replace the symbolistic Mendelian language, used here, by more definite physico-chemical conceptions." Such newer descriptions—we would say—is wholly in line with the requirements of present data on sex. In Whitman's and our own material it has been clear from the first that the results far overstep the possibility of treating them in Mendelian terms, for it has been apparent from the beginning that we have had to do not with three or four *points* merely, but with a *flowing graduated line.* In the work with the moths, however, sex is clearly described in *quantitative* terms, and we can readily believe that when the functional basis of sex can there be identified, sex will be found to accord with metabolic grades there, as it does elsewhere.

It is clear then that all of the animal-forms for which there is reasonable evidence of sex-control show important correspondences with the situation fully elucidated in the pigeons. And that where the sex-differentials known to

[14] SCIENCE, N. S., Vol. 39, June 5, pp. 832–33, 1914. Also *Jour. Exp. Zool.*, Vol. 17, November, 1914, and later papers.

[15] Abstracts of Amer. Soc. Zool., December meeting, SCIENCE, N. S., Vol. 43, 1916.

[16] *Biol. Centralbl.*, Vol. 25, 1905.

[17] *Intern. Rev. d. gesammt. Hydrobiol. u. Hydrogr.*, Vol. 4, 1911–12.

[18] Carnegie Year Book, 1915, and *Proc. Nat. Acad. Sci.*, Vol. 2, October, 1916.

[19] Goldschmidt u. Poppelbaum, *Ztschr. induct. Abstammungsl.*, Vols. VII. (1912), and XII. (1914), and other papers 1913–16 by both authors. See R. Goldschmidt, below.

[20] R. Goldschmidt, *Amer. Nat.*, Vol. L., December, 1916.

exist in the pigeon's ova have been traced in adults of the two sexes, the parallel rigorously holds there also. A general classification of male and female adult animals on the basis of a higher metabolism for the one, and a lower for the other, was indeed made by Geddes and Thomson[21] many years ago. There can now be little question that this conclusion of these authors is a correct and important one.

It remains to point out that another very old, and much-worked line of investigation supplies further confirmatory evidence for our present point of view. Studies on the effects of castration, gonad-transplantation, and gonad-extract injection, constitute a large body of observations which deal with sexual phenomena associated with the *internal secretions* of the sex-glands. These internal secretions, let it be remembered, are themselves *metabolites,* which have the capacity to *influence the metabolism* of some, many, or of all the tissues with which they came in contact, or which they may reach indirectly. A partial list of the animal forms that have been most studied in this respect is written vertically on the top of our diagram—in a position intermediate to egg and adult. The number of these animal forms might be much increased, and the names of the investigators of this aspect of the modification of sex are quite too numerous[22] to be mentioned here.

[21] "The Evolution of Sex," 1890, Humboldt Publ'g Co., New York.

[22] The following partial references are suggested by the particular animals listed in the diagram: *Stag*—Darwin (1868); Caton (1881); Fowler (1894); Rörig (1900). *Human*—Hegar (1893); Selheim (1898); Hikmet and Renault (1906); C. Wallace (1907); Tandler and Gross (1909). *Sheep*—Shattock and Seligman (1904); Seligman (1906); Marshall and Hammond (1914). *Guinea-pig*—Bouin and Ancel (1903–09); Steinach (1910–13). *Pheasant*—Gurney (1888). *Fowl* and *Duck*—Darwin (1868); Gurney (1888); Foges (1903); Shattock and Seligman (1906–07); Goodale (1910–16). *Pigeon*—Riddle (1914). *Frog*—Nussbaum (1907); Pflüger (1907); Steinach (1910); G. Smith (1912). *Inachus* and *Carcinus*—Potts (1909); G. Smith (1910–12). *Free-martin*—Lillie (1916). *Bonellia*—Baltzer (1914).

But the present point of interest is that these results, as a whole, demonstrate that *the extent of sexual modification in the experimental animal is, in general, in proportion to the immaturity of the treated animal.* That is to say, the earlier the internal secretion of the gonad is supplied or withdrawn, the more profound is the sexual modification of the individual. The stag is a form that has long been known to show thus a considerable and beautiful series. The free-martin—another Ungulate—is now known to exemplify a much earlier point at which the foreign internal secretion begins to act; and here, true to the rule that has been established elsewhere in all this general line of work, the resulting modification is correspondingly strong and striking. When, by whatever means, we effect a change in the metabolism (which is the essential thing) at a still earlier stage—in the egg-stage, in our own and in some other experimental reversals of sex,—then we obtain individuals whose sexual nature is quite thoroughly reversed; in many cases completely so, and in still other cases with varying degrees of completeness.

Professor Whitman's main decisions concerning the *nature* of sex may here be briefly stated. These decisions were that the male proceeds from a "stronger" germ, has greater "developmental energy," and "carries the processes of development farther" than does the female. I am confident that his results fully justify his conclusions; and that these are in the completest harmony with the later and fuller developments of the sex-studies in the pigeons, and thus with the theory of sex which has been outlined in these pages.

In conclusion, our present definite knowledge of the metabolic basis of sexual difference, and the methods of attack which this new knowledge brings with it, offer the surest guarantees that the problem of sex can now be studied—and, indeed, the basal facts of the problem must be studied—in the field of the elemental protoplasmic functions.

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